US009452580B2

(12) **United States Patent**
Swane

(10) **Patent No.: US 9,452,580 B2**
(45) **Date of Patent: Sep. 27, 2016**

(54) **CAP RETAINER AND A PULLEY ASSEMBLY INCLUDING THE CAP RETAINER AND METHOD OF ASSEMBLY**

(71) Applicant: **Jeffrey A. Swane**, Nixa, MO (US)

(72) Inventor: **Jeffrey A. Swane**, Nixa, MO (US)

(73) Assignee: **DAYCO IP HOLDINGS, LLC**, Troy, MI (US)

(*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 0 days.

(21) Appl. No.: **14/612,383**

(22) Filed: **Feb. 3, 2015**

(65) **Prior Publication Data**

US 2015/0145167 A1 May 28, 2015

Related U.S. Application Data

(62) Division of application No. 12/566,088, filed on Sep. 24, 2009, now Pat. No. 8,979,686.

(51) **Int. Cl.**

B62J 13/00	(2006.01)
F16D 1/00	(2006.01)
F16H 57/02	(2012.01)
F16C 33/76	(2006.01)
B29D 99/00	(2010.01)
B29C 45/14	(2006.01)
F16C 33/72	(2006.01)
F16H 55/48	(2006.01)
F16C 13/00	(2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ***B29D 99/0032*** (2013.01); ***B29C 45/14467*** (2013.01); ***F16C 13/006*** (2013.01); ***F16C 33/723*** (2013.01); ***F16H 55/48*** (2013.01); *B29K 2101/00* (2013.01); *B29L 2031/32* (2013.01); *F16C 2361/63* (2013.01)

(58) **Field of Classification Search**

CPC F16C 33/723; F16C 16/006; F16C 33/76; F16C 2326/02; B60B 27/0005

USPC 474/144; 384/489

See application file for complete search history.

(56) **References Cited**

U.S. PATENT DOCUMENTS

665,569	A *	1/1901	Little	F16C 35/073 16/DIG. 27
1,096,805	A *	5/1914	Gohlke	F16C 33/723 384/489
1,206,505	A *	11/1916	Blume	F16C 25/06 14/36

(Continued)

OTHER PUBLICATIONS

PCT, International Search Report and Written Opinion, PCT/US2010/049082 (Nov. 5, 2010).

(Continued)

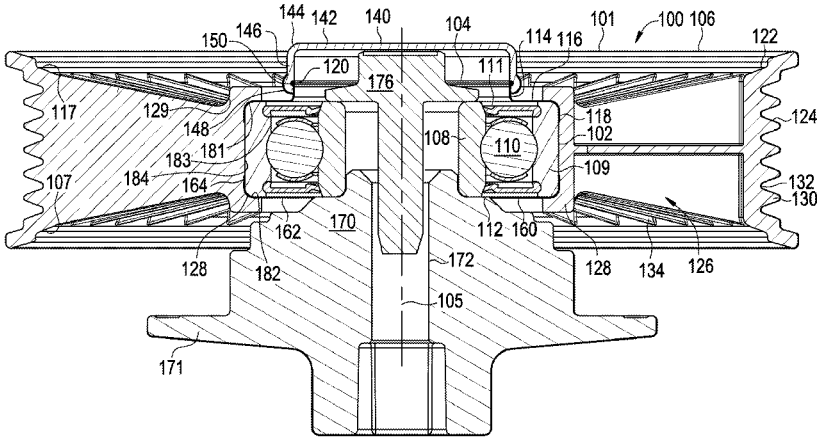
Primary Examiner — Henry Liu

(74) *Attorney, Agent, or Firm* — Thompson Hine LLP

(57) **ABSTRACT**

An insert moldable cap retainer for securing a bearing cap to a pulley assembly is disclosed. The cap retainer includes a hollow neck configured to receive a bearing cap, a plate that extends outward from the neck with the neck protruding upward from the plate, and a continuous or discontinuous flange extending downward from the outer periphery of the plate. The plate is configured to be juxtaposed with an upper surface of an outer race of a bearing and the flange is configured to be juxtaposed with an outer surface of the outer race of the bearing when the cap retainer is positioned on the bearing. The cap retainer and bearing are insert moldable together to have an integral pulley body connected thereto. A pulley assembly is also disclosed that includes the insert moldable cap retainer.

4 Claims, 12 Drawing Sheets



(51) **Int. Cl.**

B29L 31/32	(2006.01)
B29K 101/00	(2006.01)

(56) **References Cited**

U.S. PATENT DOCUMENTS

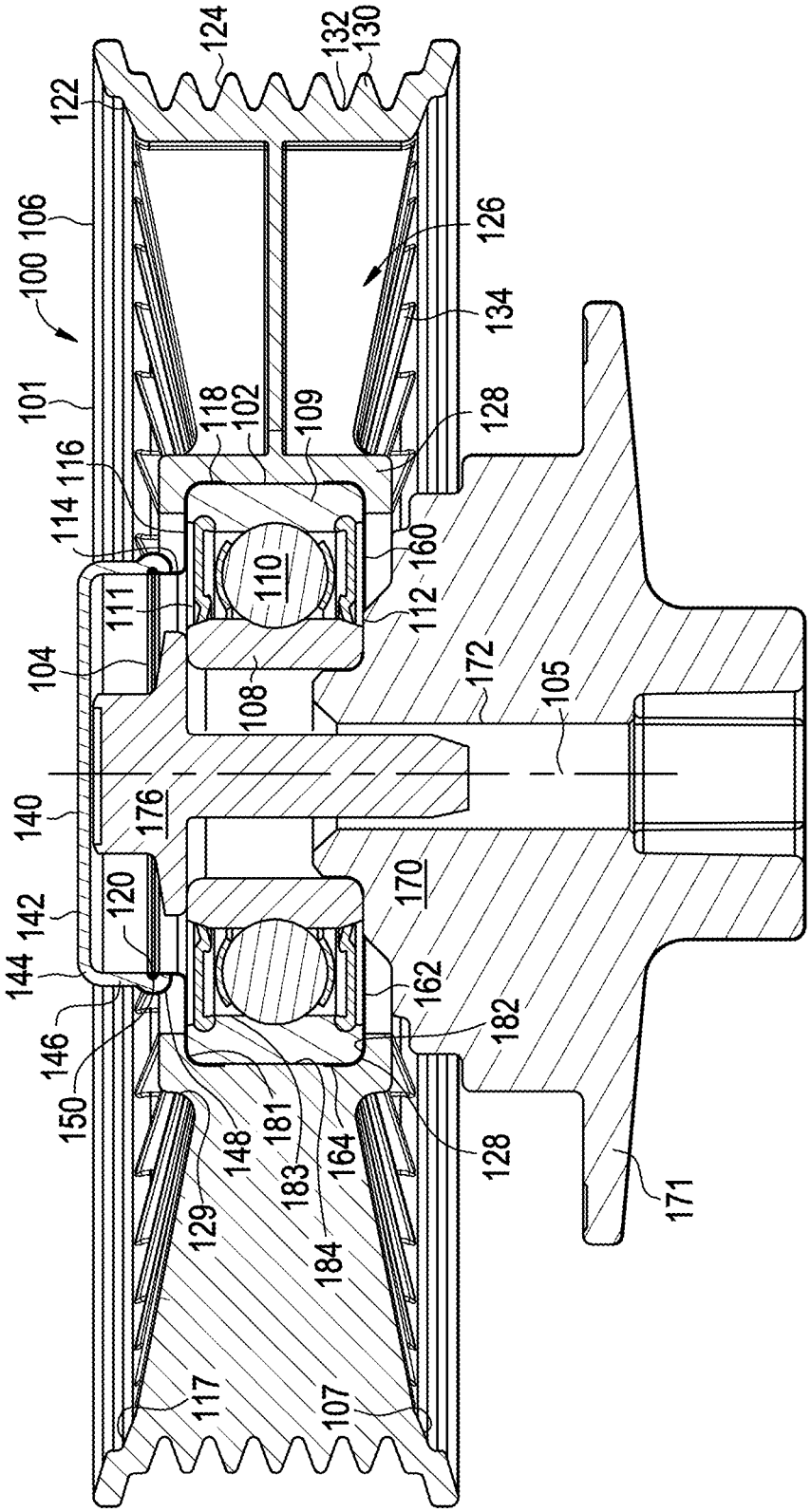
1,603,596	A *	10/1926	Harley	B60B 27/023	384/480
1,693,538	A *	11/1928	Allen	F16B 37/00	384/489
1,875,097	A *	8/1932	Mitchell	F16C 33/6607	384/487
2,044,380	A *	6/1936	Cobb	F16C 33/723	384/488
2,221,553	A *	11/1940	Okun	B60B 27/0005	277/369
2,266,300	A *	12/1941	Bebinger	F16C 33/78	384/489
2,512,148	A *	6/1950	Gaines	B60B 27/001	16/46
2,622,934	A *	12/1952	Phelps	B60B 27/02	301/105.1
2,622,944	A *	12/1952	Bergstrom	F16C 19/36	384/489
2,717,808	A *	9/1955	Owsen	A63C 17/02	152/47
2,759,243	A *	8/1956	Smith	F16C 25/06	29/441.1
3,010,771	A *	11/1961	Cogger	B60B 27/0005	277/369
3,126,232	A *	3/1964	Reilly	B60B 7/00	301/108.1
3,169,809	A *	2/1965	Pendleton	B60B 7/002	277/402
3,330,563	A *	7/1967	De Puydt	B60P 3/10	277/346
3,460,437	A *	8/1969	Roggenburk	F01C 21/02	384/489
3,460,874	A *	8/1969	Johnson	B60B 7/002	277/572
3,537,725	A	11/1970	Frost		
3,577,833	A *	5/1971	Skelton	F16J 10/02	277/530
3,770,992	A *	11/1973	Veglia	F16C 33/723	384/489
4,025,132	A *	5/1977	Watanabe	F16C 13/006	384/130
4,054,335	A *	10/1977	Timmer	A63C 17/223	16/46
4,113,328	A	9/1978	VanderMeulen		
4,230,230	A *	10/1980	Mumford	B65D 41/62	215/277
4,342,490	A *	8/1982	Swinley	F16C 33/723	384/489
4,364,614	A *	12/1982	Weis	F16C 33/723	220/285
4,368,933	A *	1/1983	Motsch	F16C 33/723	384/130
4,793,457	A	12/1988	Siewert		
4,960,335	A *	10/1990	Otto	F16C 19/386	277/562
5,172,984	A *	12/1992	Lederman	B60B 7/002	384/489
5,190,502	A	3/1993	Gardner et al.		
5,380,103	A *	1/1995	Lederman	B60B 7/002	301/108.3
5,590,968	A *	1/1997	Dretzka	F16C 35/067	384/272
5,620,385	A	4/1997	Cascionale et al.		
5,678,934	A *	10/1997	Fischer	F16C 23/084	384/489
5,711,393	A	1/1998	Gage		
5,711,617	A *	1/1998	Scheller	F16C 23/084	384/484
5,711,618	A *	1/1998	Waskiewicz	F16C 23/084	384/489
5,798,589	A	8/1998	Ohi et al.		
5,947,612	A *	9/1999	Dennison Buck	F16C 35/077	384/489
6,149,244	A *	11/2000	Wagner	B60B 27/001	29/898.07
6,435,722	B1 *	8/2002	Horng	F16C 33/10	384/135
6,485,185	B1 *	11/2002	Conway, Jr.	F16C 19/364	384/480
6,854,893	B2 *	2/2005	Schmidt	F16C 13/006	384/477
6,863,631	B2	3/2005	Meckstroth et al.		
6,872,005	B2 *	3/2005	Steinebach	F16C 35/045	384/489
7,011,221	B2	3/2006	Smith et al.		
7,011,593	B2 *	3/2006	Schenk	F16C 13/006	384/477
7,448,807	B2 *	11/2008	Schenk	F16C 13/006	384/417
8,012,053	B2 *	9/2011	Filip	F16C 13/006	474/144
2002/0102039	A1 *	8/2002	Horng	F16C 33/10	384/279
2003/0039422	A1 *	2/2003	Nisley	F16C 33/76	384/477
2006/0160647	A1	7/2006	Swane		
2007/0072714	A1	3/2007	Filip		

OTHER PUBLICATIONS

US, Office Action, U.S. Appl. No. 12/566,088 (Mar. 27, 2012).
US, Office Action, U.S. Appl. No. 12/566,088 (Aug. 15, 2012).
US, Advisory Action, U.S. Appl. No. 12/566,088 (Nov. 20, 2012).
US, Office Action, U.S. Appl. No. 12/566,088 (Apr. 8, 2014).
US, Office Action, U.S. Appl. No. 12/566,088 (Jul. 31, 2014).
US, Advisory Action, U.S. Appl. No. 12/566,088 (Oct. 9, 2014).
US, Notice of Allowance, U.S. Appl. No. 12/566,088 (Nov. 7, 2014).

* cited by examiner

FIG. 1


124
132
130
122
106
100
126
134
101
118
102
109
128
116
114
160
110
111
112
104
172
105
108
140
176
120
170
142
144
162
182
146
150
148
181
183
164
128
171
129
184
117
107

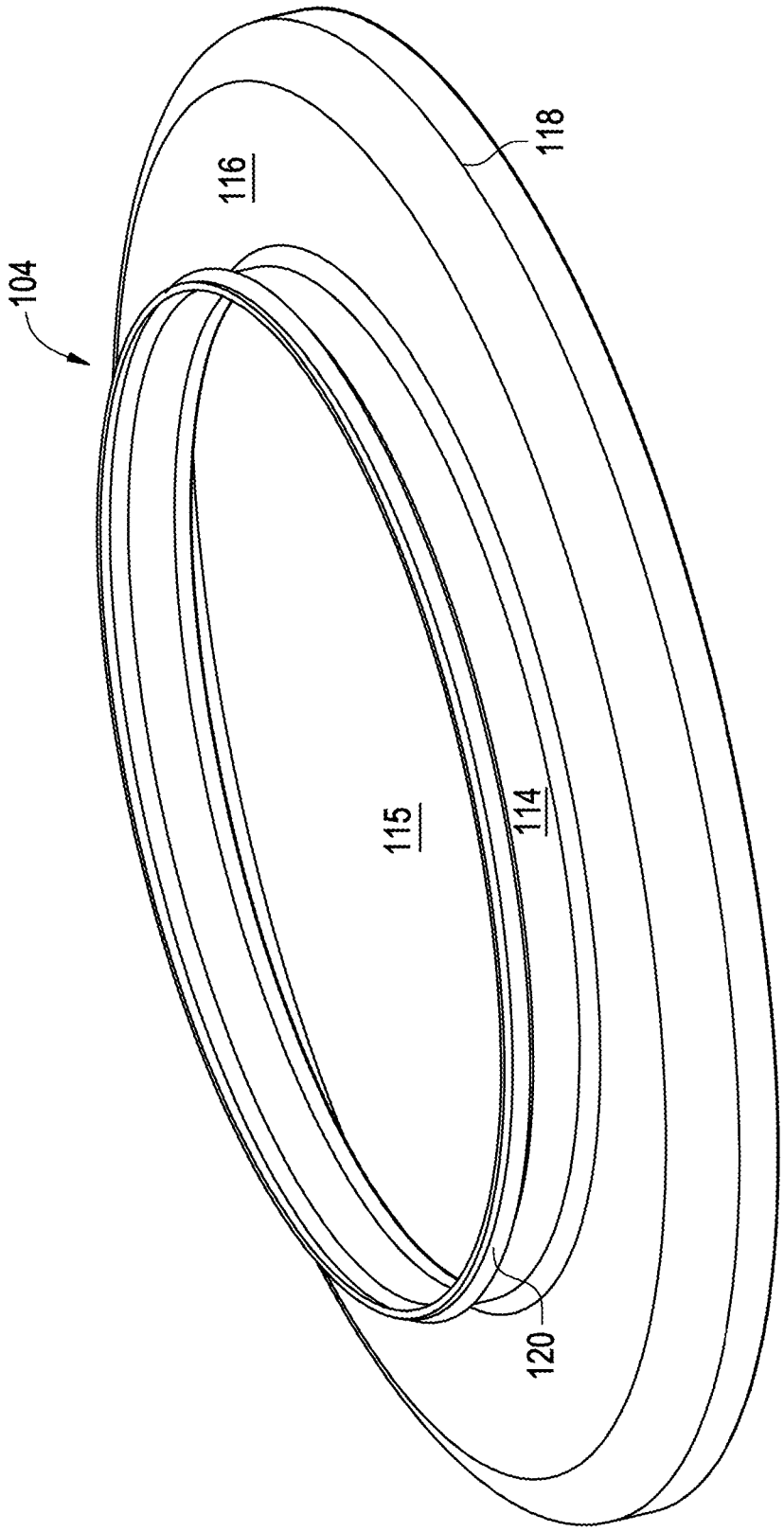


FIG. 2

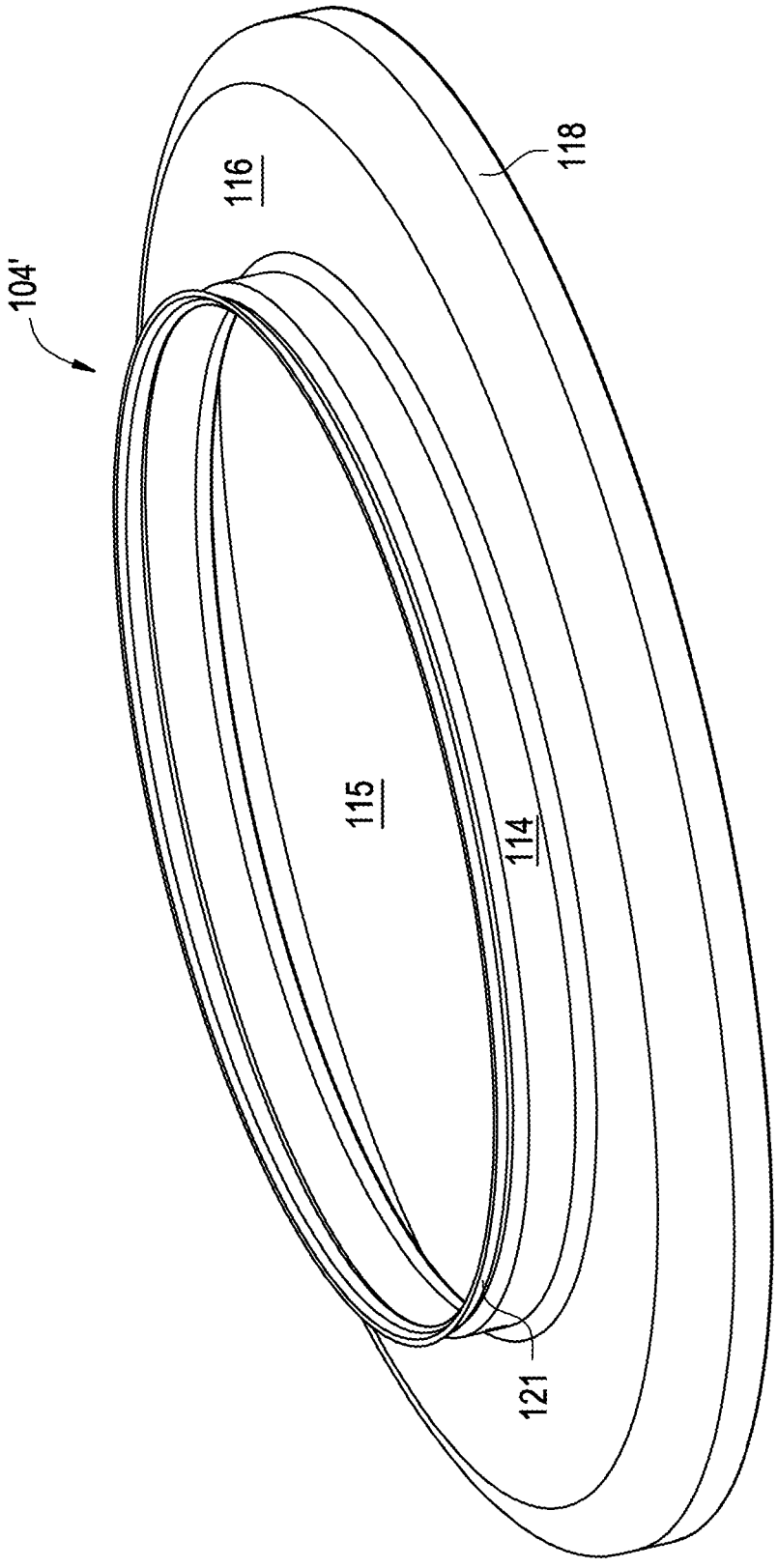
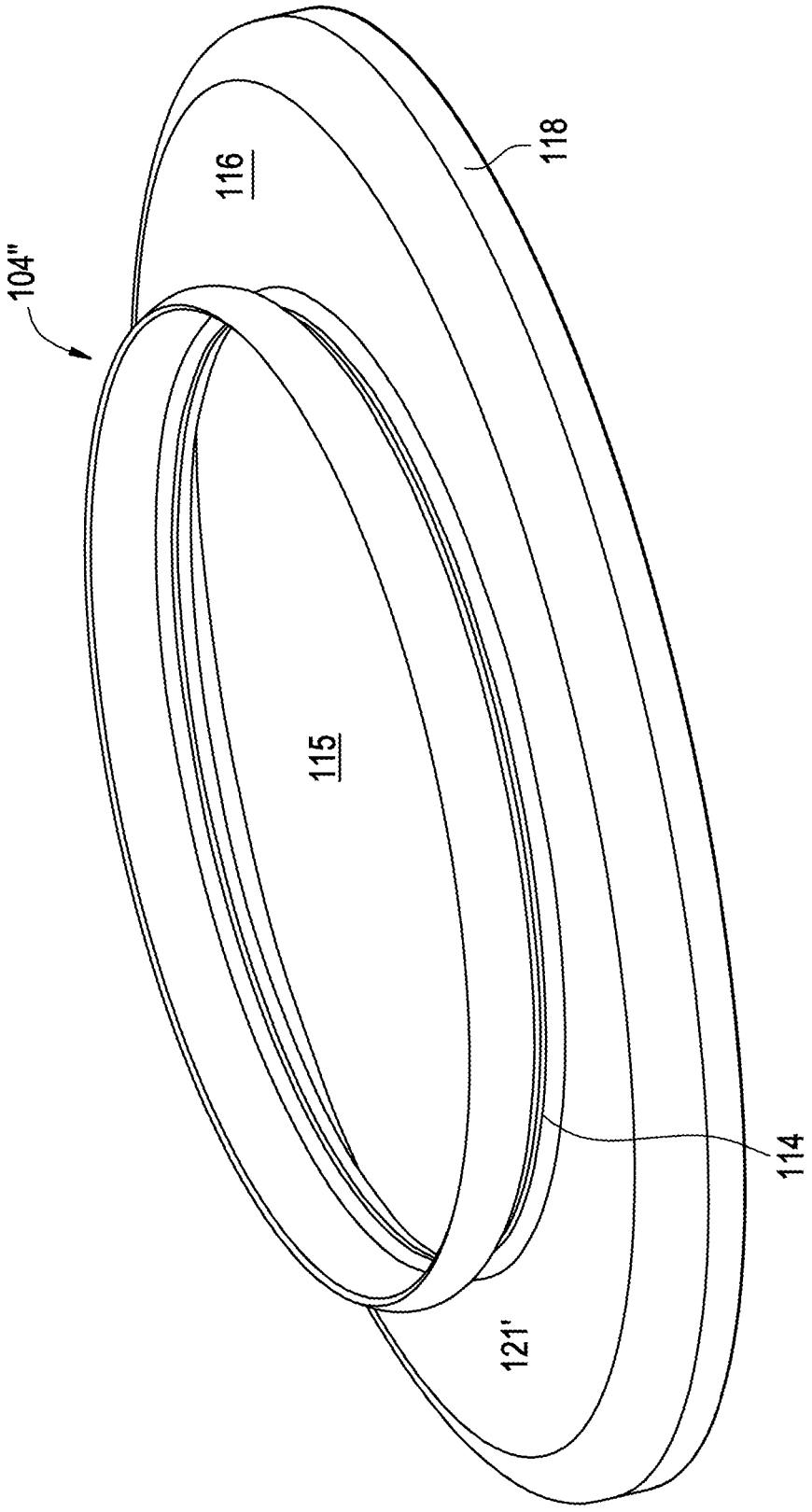


FIG. 3A

FIG. 3B



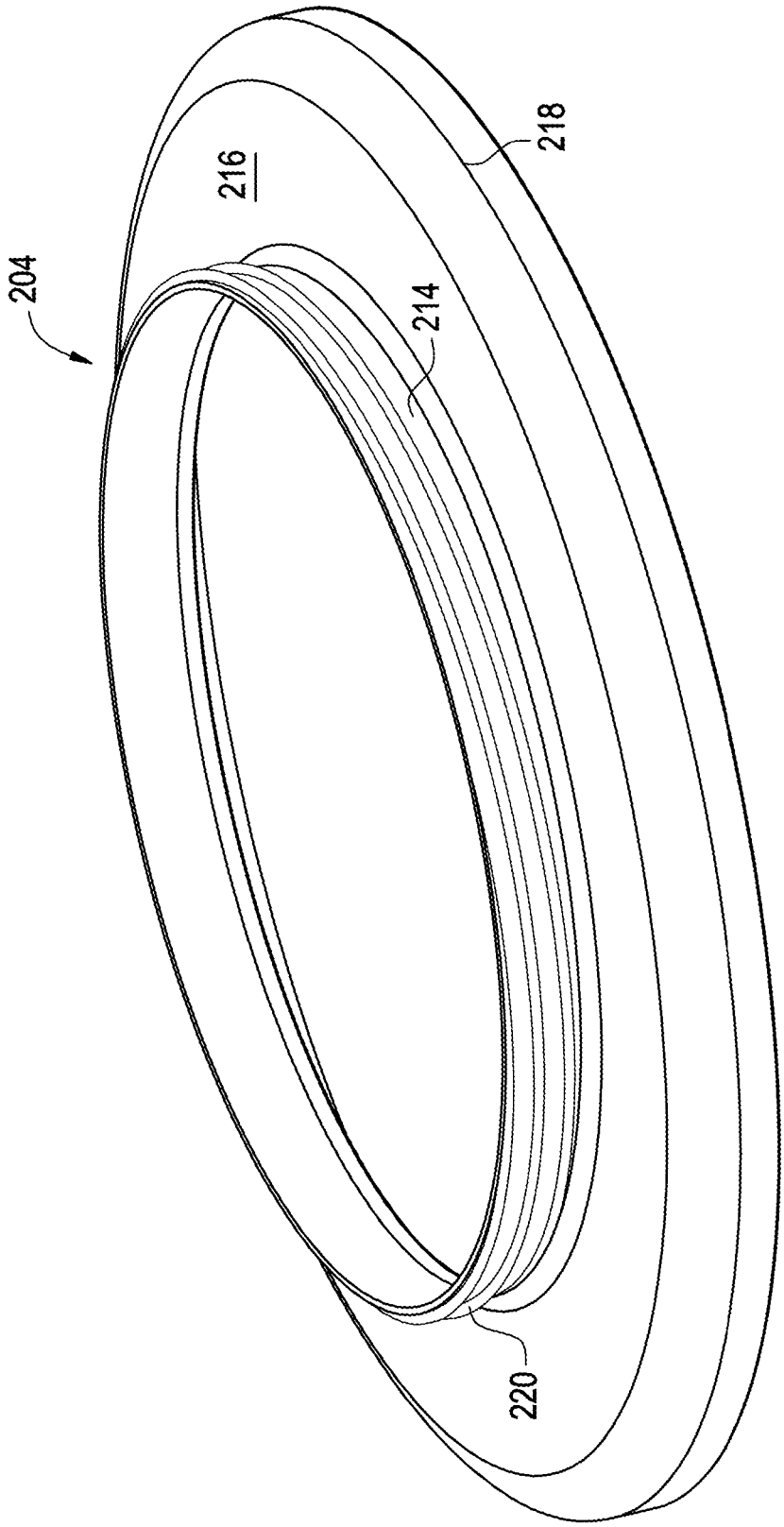


FIG. 4

FIG. 5

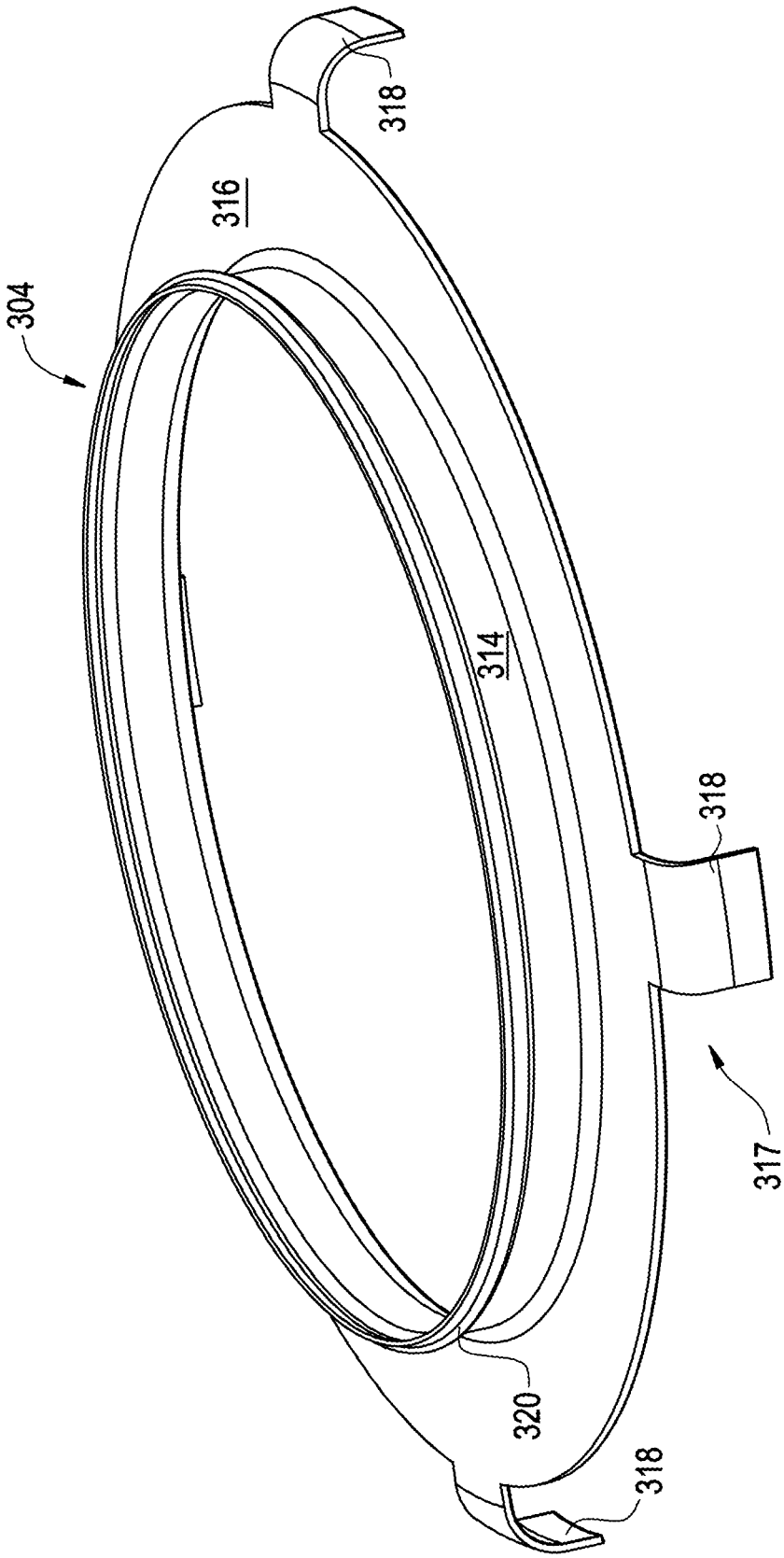
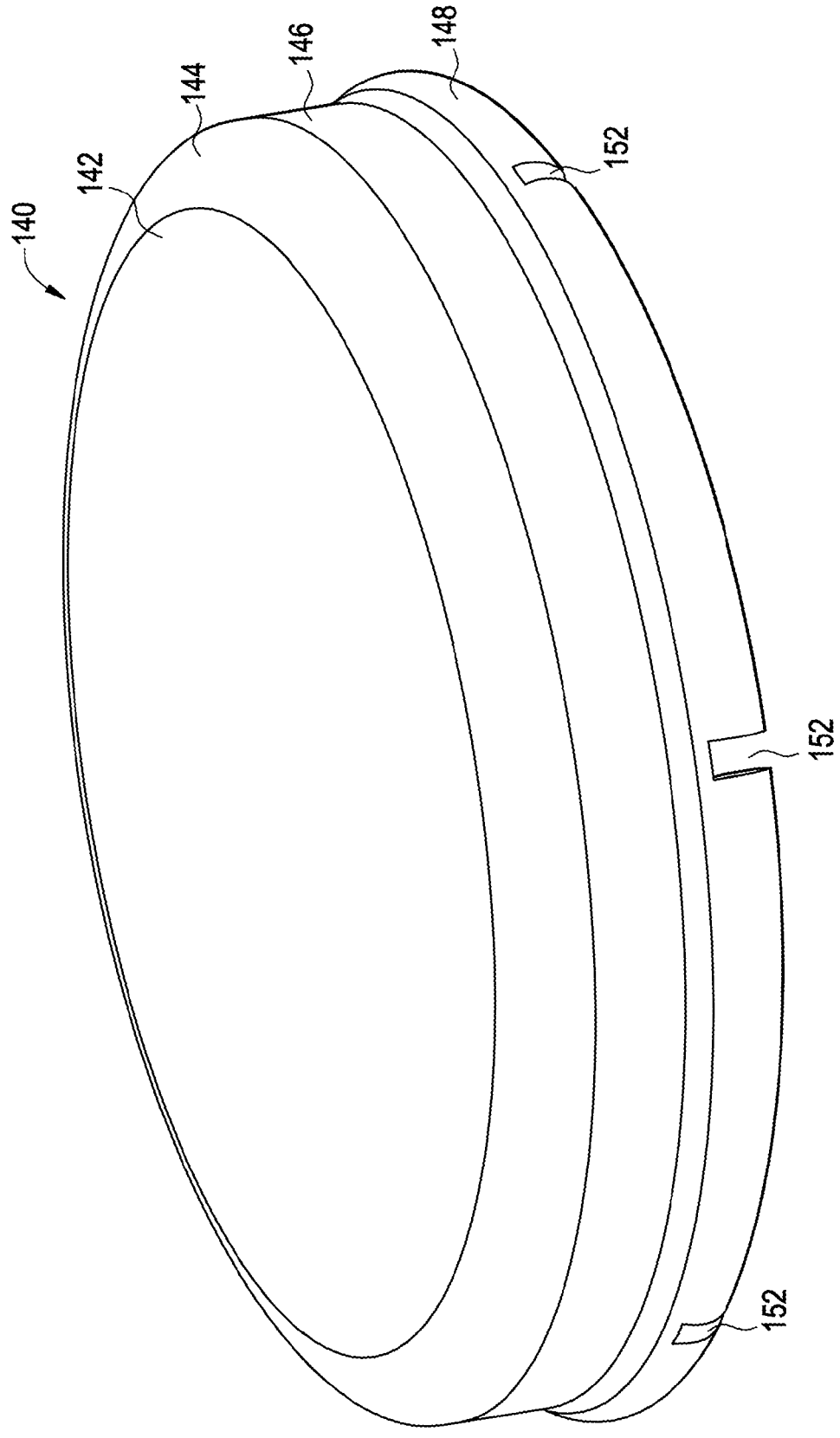


FIG. 6



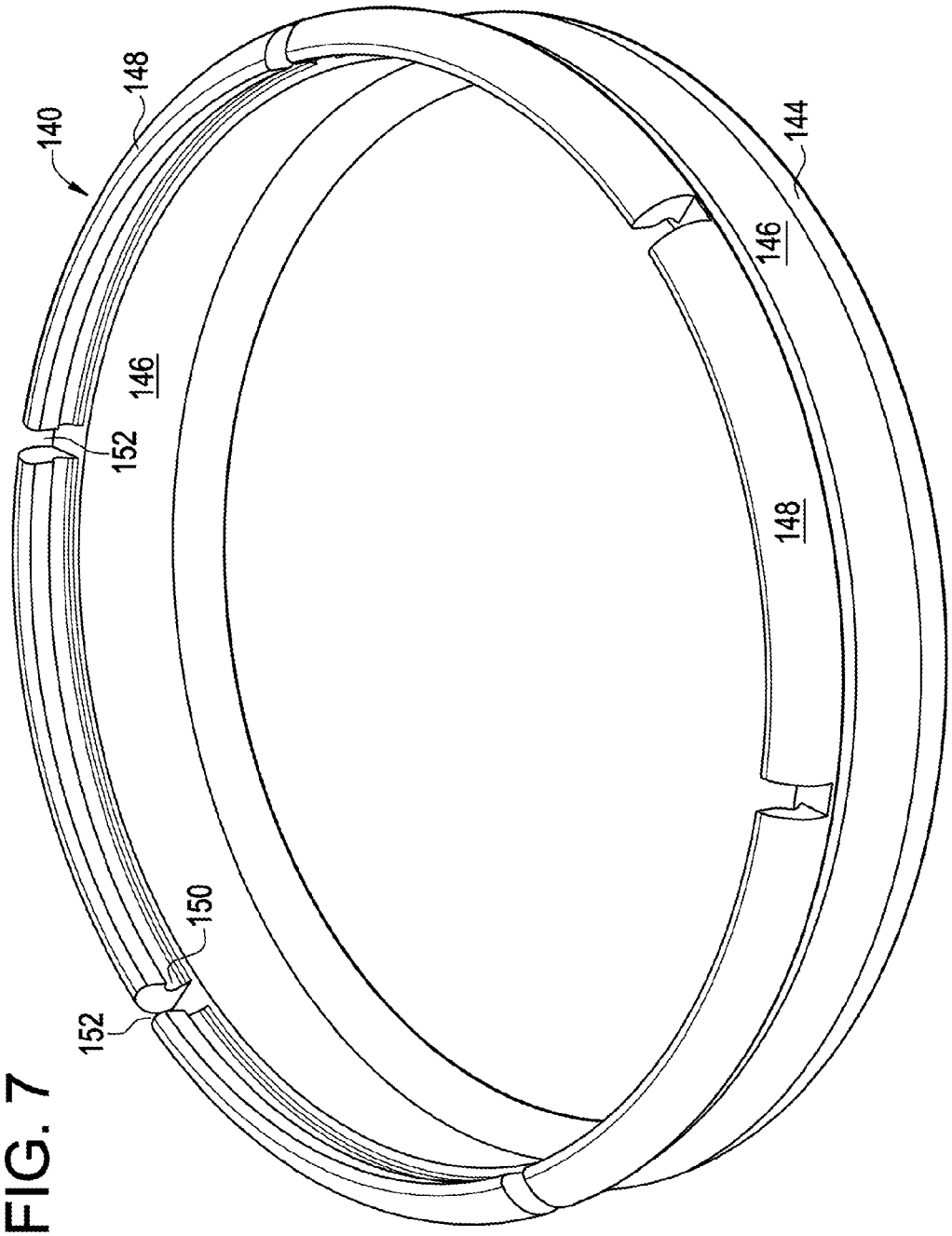


FIG. 7

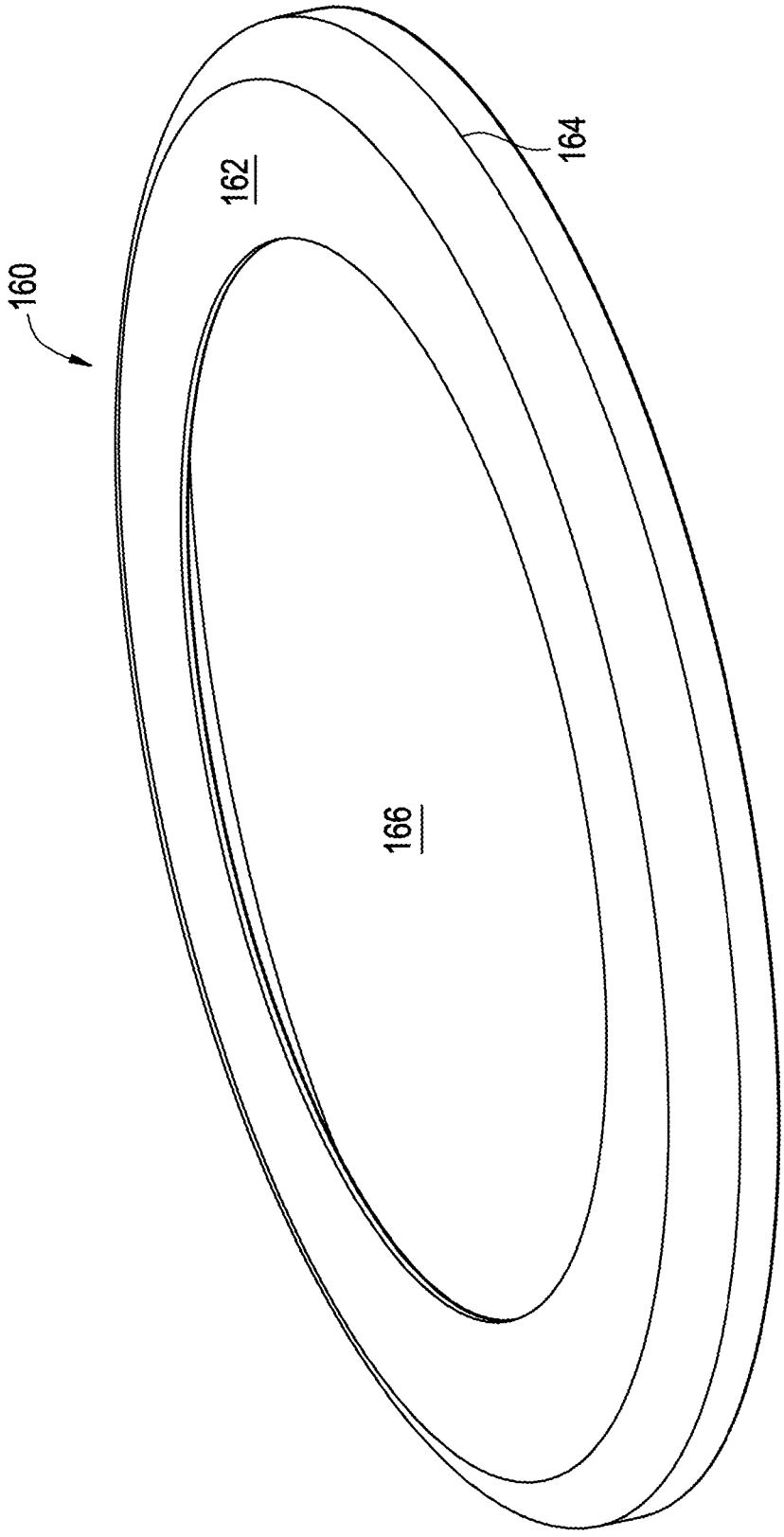


FIG. 8A

FIG. 8B

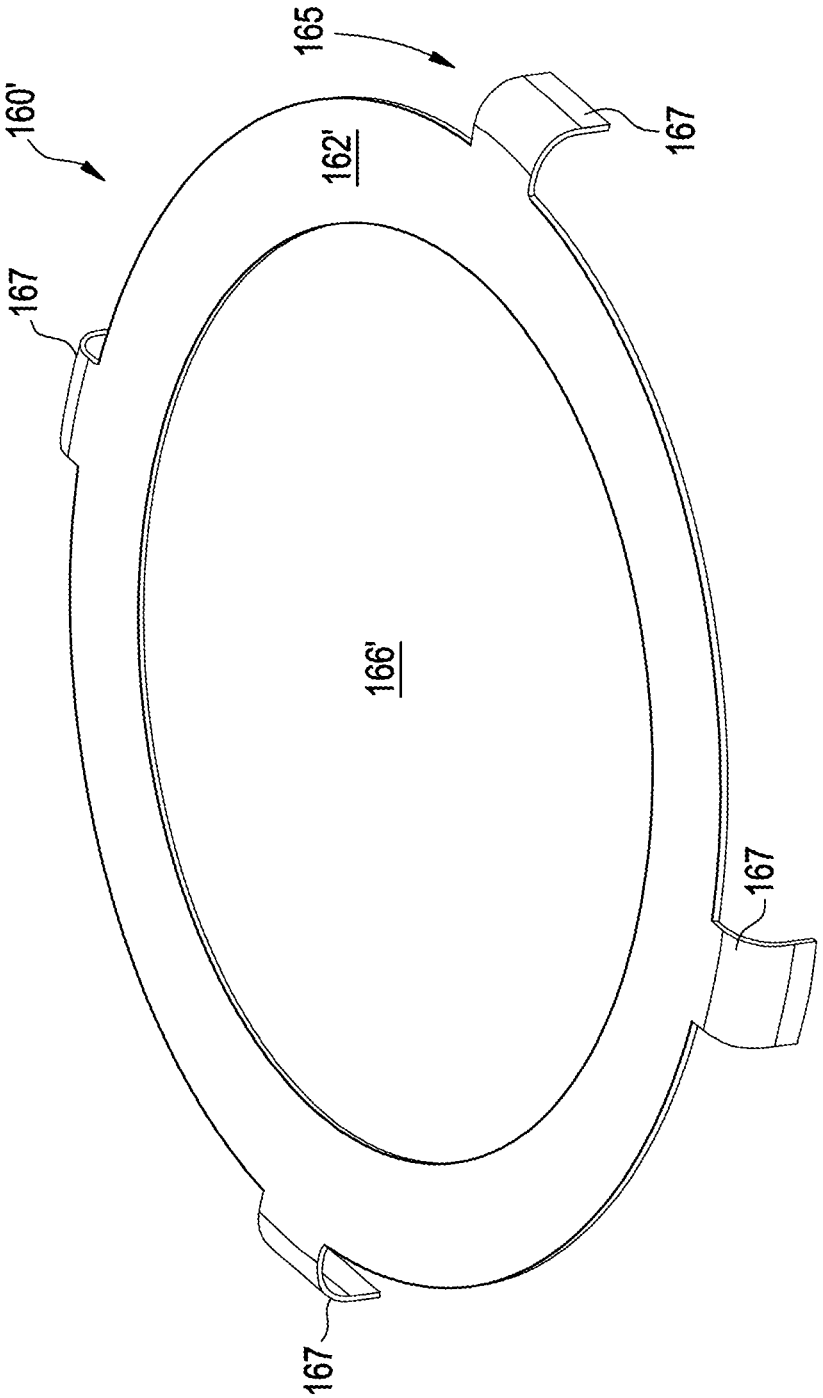


FIG. 9

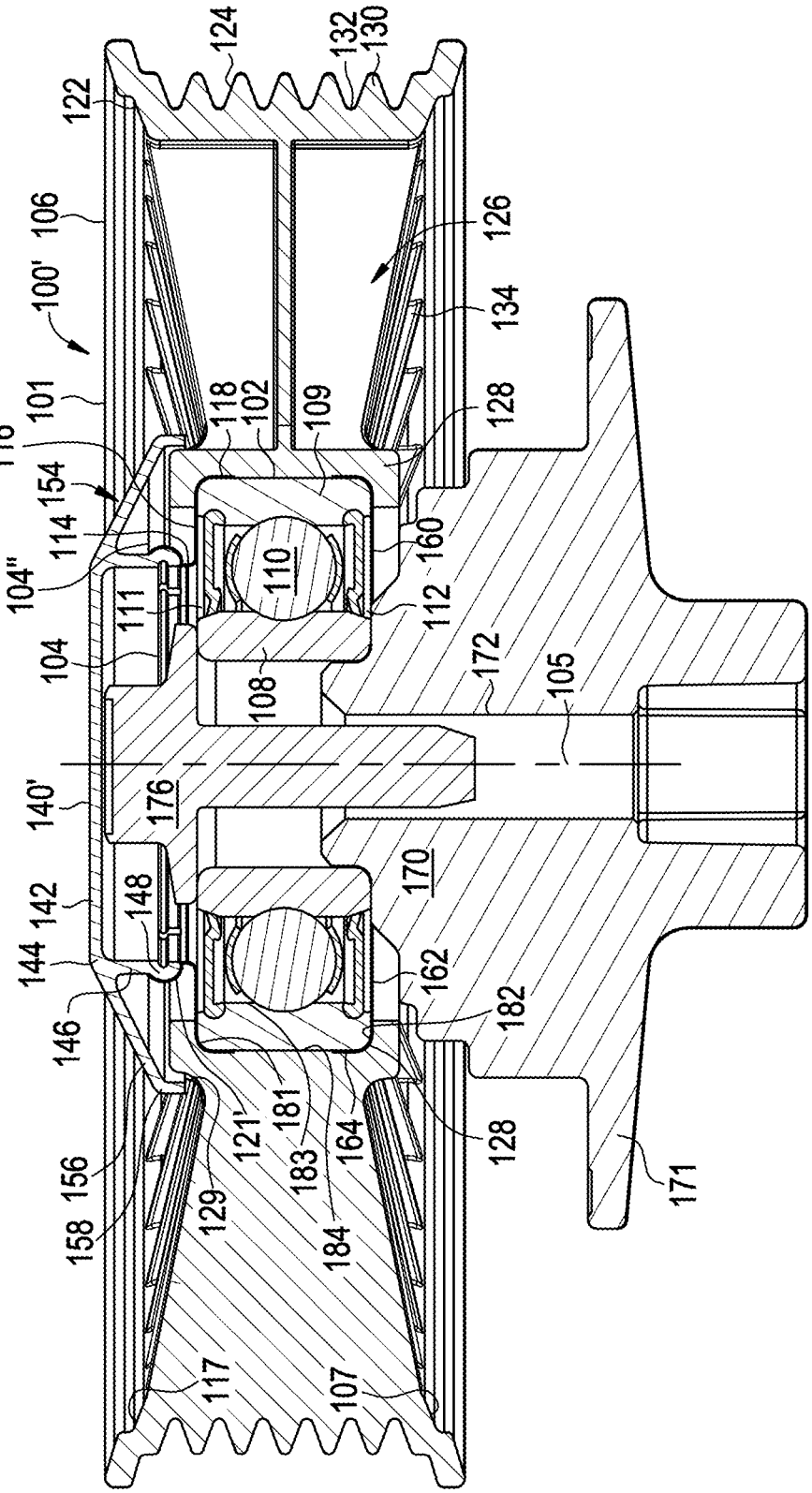

124
132
130
122
106
126
100'
134
101
118
102
109
128
116
154
114
104"
110
160
111
112
104
172
108
105
140'
176
170
142
148
144
162
182
146
181
121'
183
164
128
156
129
184
171
158
117
107

FIG. 10A

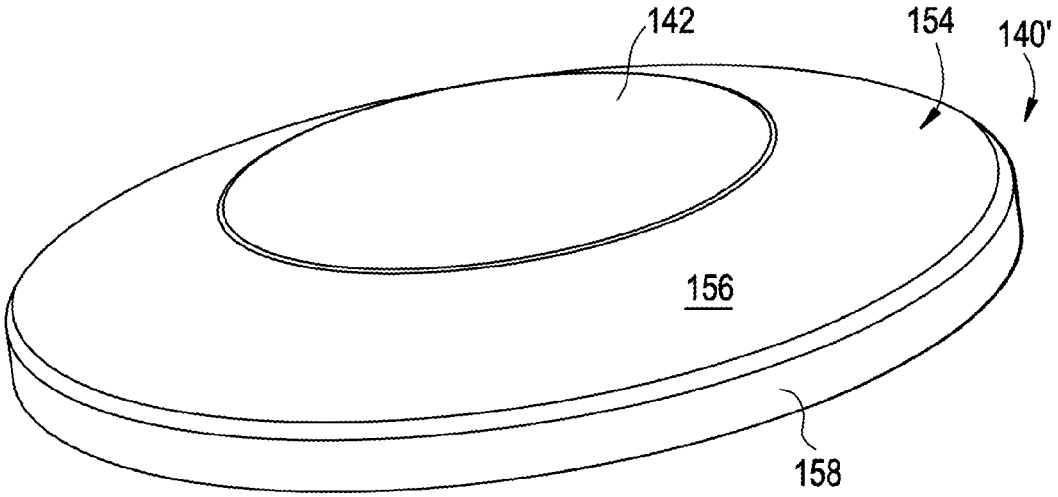
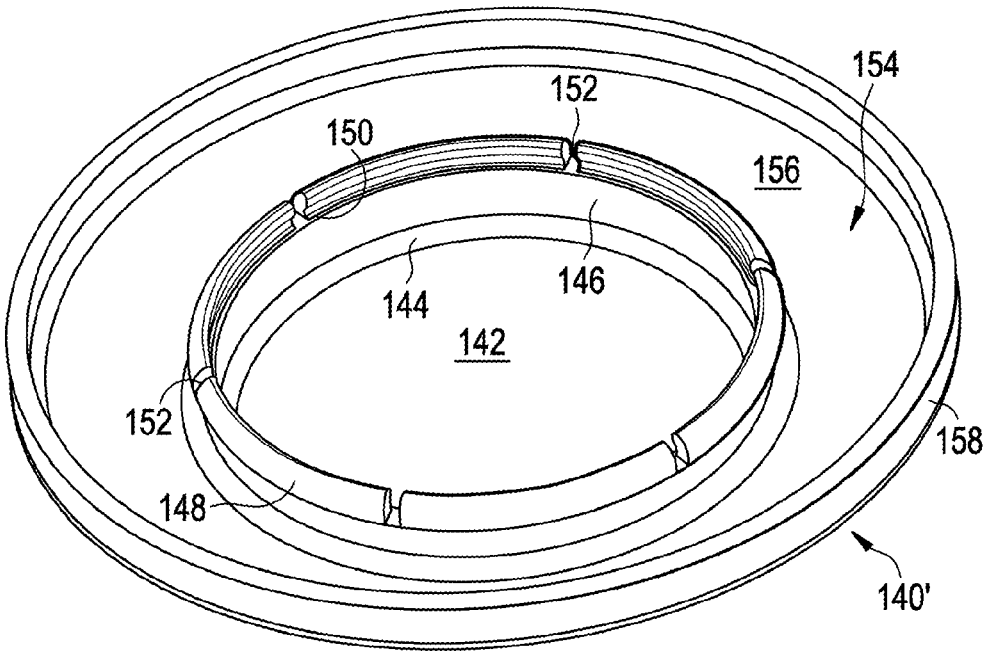


FIG. 10B



CAP RETAINER AND A PULLEY ASSEMBLY INCLUDING THE CAP RETAINER AND METHOD OF ASSEMBLY

This is a divisional application of application Ser. No. 12/566,088 filed Sep. 24, 2009.

TECHNICAL FIELD

The present invention relates generally to a pulley assembly having a cap retainer for retaining a bearing cap to protect an exposed side of a bearing from contaminants, and more particularly to an insert moldable cap retainer.

BACKGROUND

Pulleys such as drive pulleys (both front-side and backside), idler pulleys, tensioner pulleys, and the like are frequently employed for automotive use, e.g. to drive or tension a belt of a drive system. The belt drive system can be accomplished by using a driver pulley and one or more idler pulleys and a belt trained around the belt surface of each of the various pulleys. The belt surface may be, for example, smooth, deep V-shaped, cogged or multi-ribbed.

In such automotive and other industrial applications, contaminants such as dust, sand, salt, and/or other foreign matter can find a way into the pulley's bearing. Bearings wear more quickly when left open to contaminants, thereby reducing the lifespan of the bearing. Contaminants can also cause the ball or rolling element to seize up, which is a serious problem. Seizing can cause the driving belt to break as a result of the belt sliding on a locked pulley.

A bearing seal is a first line of defense against contaminants, but is often not enough. Various sealing rings or covers to reduce the amount of dirt and other contaminants like those described in U.S. Pat. No. 3,537,725, No. 4,113,328, and No. 7,011,593 have been attempted. Some bearing caps have been designed to attach directly to the pulley or pulley body, for example the snap-on bearing cap described in U.S. Pat. No. 4,793,457 and the flanged bearing cap grooved bearing cap retainer combination described in U.S. Published Patent Application 2007/0072714. The aforementioned pulley-bearing cap designs are not ideal, especially for injection molded pulley assemblies.

Injection molding is a well-known technique for forming pulley assemblies. However, the molds place limits on the complexity of the pulley body's design. Particularly, complex features for attaching a bearing cap to the pulley body, for example snap-fit configurations, are difficult to achieve due to the complexity of the under cuts required to form such features within the mold.

Accordingly, a new design for retaining a bearing cap on a pulley is needed that does not increase the complexity of the pulley body's design and accordingly the design of the mold used to form the pulley body.

SUMMARY

One aspect of the disclosed invention is an insert moldable cap retainer for securing a bearing cap to a pulley assembly. The insert moldable cap retainer includes a hollow neck configured to receive a bearing cap, a plate extending outward from the neck with the neck protruding from the plate, and a continuous or discontinuous flange extending downward from the outer periphery of the plate. The hollow neck defines an opening allowing access to the bearing and the fastener connecting the pulley to a mounting base. The plate is configured to be juxtaposed with an upper surface of an outer race of a bearing and the flange is configured to be juxtaposed with an outer surface of the outer race of the bearing. The cap retainer is insert-moldable with the bearing to have a pulley body molded integrally to the cap retainer and the bearing.

In another aspect, a pulley assembly including the insert moldable cap retainer is disclosed. The pulley includes a bearing that includes an inner race, an outer race, and a rolling element between the inner race and the outer race, a cap retainer having a hollow neck configured to receive a bearing cap and a plate extending outward from the neck with the neck protruding upward from the plate, and an injection molded pulley body integrally molded to the bearing and the cap retainer. The plate is configured to be juxtaposed with the upper surface of the outer race of the bearing and the cap retainer is positioned on the bearing with the plate juxtaposed with the upper surface of the outer race.

In another aspect a pulley assembly including a mounting base and a pulley having the insert moldable cap retainer is disclosed. The mounting base defines an axis of rotation and the pulley is mounted on the mounting base for rotation about the axis. The pulley comprises a bearing comprising an inner race, an outer race, and a rolling element between the inner race and the outer race, a cap retainer comprising a hollow neck configured to receive a bearing cap and a plate extending outward from the neck with the neck protruding upward from the plate, a continuous or discontinuous flange extending downward from the outer periphery of the plate, and a pulley body integrally molded to the bearing and the cap retainer. The cap retainer is positioned on the upper surface of the bearing with the plate adjacent to the upper surface and the flange adjacent to the outer surface of the outer race of the bearing.

In another aspect a method for molding a pulley is disclosed. The method includes providing an injection mold configured to form a pulley body, positioning a bearing comprising an inner race, an outer race, and a rolling element between the inner race and the outer race in the injection mold, positioning a cap retainer on an upper surface of the bearing, and injecting a resin into the injection mold to form a pulley body integrally molded to the bearing and the cap retainer. The cap retainer includes a hollow neck configured to receive a bearing cap and a plate extending outward from the neck with the neck protruding upward from the plate. The method may also include positioning a shield on the lower surface of the bearing before injecting the resin.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. **1** is front, cross-section of one embodiment of a pulley assembly including a cap retainer and bearing cap.

FIG. **2** is a front perspective view of one embodiment of the cap retainer of FIG. **1**.

FIGS. **3**A & **3**B are front perspective views of alternate cap retainer embodiments having alternate inside-snap fit configurations.

FIG. **4** is a front perspective view of another embodiment of the cap retainer.

FIG. **5** is a front perspective view of another embodiment of a cap retainer.

FIG. **6** is a front perspective view of one embodiment of the bearing cap of FIG. **1**.

FIG. **7** is a bottom perspective view of the bearing cap of FIG. **6**.

FIGS. **8**A and **8**B are front perspective views of two embodiments of the bearing shield of FIG. **1**.

FIG. **9** is a front, cross-section of another embodiment of a pulley assembly including an alternate embodiment for the bearing cap.

FIGS. **10**A and **10**B are top and bottom perspective views of the bearing cap of FIG. **9**.

DETAILED DESCRIPTION

The new cap retainer and bearing cap disclosed herein eliminates the need to mold an additional feature into the pulley body to retain a bearing cap, which makes the mold and the molding process simpler. Another advantage of the cap retainer and bearing cap, depending upon the features used to attach the bearing cap to the cap retainer, is that the bearing cap is removable. The present cap retainer and bearing cap also make mold modifications minimal and should be universally useful for all pulley bodies.

Referring now to the embodiment shown in FIG. **1**, a pulley assembly, generally designated **100**, is shown that includes a pulley **101** having an axis of rotation **105**, a mounting base **170** for seating the pulley thereon, a cap retainer **104**, a bearing cap **140**, and a fastener **176**. The pulley **101** is shown mounted to the mounting base **170** and generally contain an aperture **172** shaped to engage the fastener **176**, such as a bolt to provide a clamping force and to aid in securing components of the pulley assembly together. The aperture in the pulley is typically centrally located and passes through a bearing **102** housed within an opening within the pulley body **106**. As appreciated by one skilled in the art, the fastener **176** may also be a screw, pin, rivet, or other fasteners capable of providing the clamping force.

The pulley **101** is rotatable relative to the mounting base **170** about axis **105**. Mounting base **170** may be disposed at one end of a tensioner arm **171** for tensioning a belt of a drive system, such as those disclosed in U.S. Pat. No. 5,190,502, No. 5,620,385, No. 6,863,631, but not limited thereto. The side of the pulley positioned on the mounting base **170** is referred to herein as the "arm side" **107** and the opposite side of the pulley is referred to as the "exposed side" **117**. While the mounting base **170** is described for use with a belt tensioner, the application of the bearing cap and cap retainer is not limited thereto.

Pulley **101** includes a bearing **102**, a cap retainer **104**, a pulley body **106**, and optionally an arm side shield **160** positioned on the arm side **117** opposite the cap retainer **104**, and a bearing cap **140** connected to the cap retainer **104**. The bearing **102** includes an inner race **108**, an outer race **109**, and one or more rolling elements **110** positioned between the inner and outer races and has an upper surface **111** and a lower surface **112**. The bearing **102** may be a ball type bearing, a journal bearing, or a roller bearing, and may alternatively include other suitable roller elements **110**, such as rollers or a cartridge. The outer race **109** has an upper surface **181**, a lower surface **182**, an inner surface **183**, and an outer surface **184**.

The cap retainer **104** is positioned on the upper surface **111** of the bearing **102** and the pulley body **106** is injection molded integrally to the bearing and the cap retainer, i.e., the bearing and cap retainer are insert molded. If an arm side shield **160** is present it may be positioned on the lower surface of the bearing **102** and may be insert molded at the same time as the cap retainer.

Pulley body **106** may include an outer ring **122** that includes a belt-running surface **124** for engaging a belt, such as an automotive power transmission belt, a core **126** that radially supports the outer ring **122** and a bearing housing portion **128** centrally located within the core. The bearing housing portion **128** may have a neck **129** that transitions the bearing housing portion **128** into the core **126**.

The bearing **102** is located within the bearing housing portion **128** of the pulley body **106** such that the outer ring **122** including the belt-running surface **124**, the core **126**, the bearing housing portion **128**, and the outer race **109** rotate together relative to the inner race **108**. Core **126** may include a web of supports **134** extending outward from the central portion of the core.

The belt-running surface **124** may be generally flat or may have a textured surface, such as the non-limiting example of an undulating contour of peaks **130** separated by valleys **132** as shown in FIG. **1**. The contour of the belt-running surface **124** is formed to correspond with a mating contour of a belt (not shown) that engages the belt-running surface during use. These mating contours can reduce slippage between the belt and the belt-running surface **124** during operation. As an alternative to undulations, the belt-running surface **124** may be formed for use with other input devices, such as a toothed belt, a V-shaped belt, etc.

Pulley body **106** may be formed by injection molding a material around an insert including the bearing **102**, the cap retainer **104**, and optionally arm side shield **160**. The pulley body may be formed of one material or a plurality of materials. As used herein, "material" refers to the substance or substances out of which a thing is made and can refer to a mixture such as a composite including a filler disposed within a resin matrix. In one embodiment, it may be advantageous to form the pulley body from at least two distinct materials that can be selected to optimize certain physical properties of the pulley, such as wear resistance for the outer ring **122** and/or the belt-running surface **124** and compressive strength for the core **126** as taught in U.S. Published Patent Application 2006/0160647 to Swane. Suitable materials include, for example, polymers such as nylon 6, nylon 6/6, nylon 6/6/6 copolymer or blend, nylon 4/6, polypropylene, polyethylene, polystyrene, polyvinyl chloride, polyester, acetal, polyetherimide, polysulfone, polyphenylene sulfide, polyether sulfone, polyetheretherketone, polythalamide, and many other engineering plastics as appreciated by one of skill in the art, even those including fibers may be used.

Now referring to FIGS. **1**-**3**B, cap retainers **104**, **104'**, and **104"** comprise a hollow generally cylindrical neck **114** configured to receive the bearing cap **140** and extending upward from a generally annular plate **116**. The plate **116** extends radially outward from the base of the neck and has a flange **118** extending from the plate's outer periphery in a direction that is opposite from the direction the neck extends. The neck **114** defines an opening **115** that allows access to the bearing and receives the fastener **176**. The neck **114** is shown as an annular neck, but is not limited thereto, as any other shape that enables the bearing cap **140** to be connected to the neck is possible. The neck **114** includes a feature or features to connect the bearing cap **140** to the neck. The feature may be an outside snap-fit projection **120** shown in FIGS. **1**-**2**, an inside snap-fit feature **121** shown in FIG. **3**A, or an inside snap-fit recess **121'** shown in FIG. **3**B.

Now referring to FIG. **4**, another embodiment of the cap retainer, generally designated **204**, is shown that include threads **220** as the feature(s) for connecting the bearing cap **140** to neck **214**. The cap retainer **204** is configured similarly to those described above having a hollow generally cylindrical neck **214** extending upward from a generally annular

plate **216**. The plate **216** extends radially outward from the base of the neck **214** and has a flange **218** extending from the plate's outer periphery in a direction that is opposite from the direction the neck extends. Alternatively, one skilled in the art will appreciate that the bearing cap may be connected to the cap retainer by other means including but not limited to spot welding, spin welding, press fitting, latching, and deforming the outer flange of the bearing cap in response to pressing the center of the top of the bearing cap.

Now referring to FIG. **5**, another embodiment of a cap retainer, generally designated **304**, is shown. Embodiment **304** includes a hollow generally cylindrical neck **314** extending upward from a generally annular plate **316**. The plate **316** extends radially outward from the base of the neck **314**. Embodiment **304** includes a discontinuous flange **317** extending from the outer periphery of plate **316** in a direction opposite from the neck **314**. The neck **314** includes an outside snap-fit projection **320** for connecting to and retaining a bearing cap. Alternately, neck **314** may have an inside snap-fit projection, threading, latches, or other connecting means for retaining a bearing cap. The discontinuous flange **317** is illustrated as one or more downward extending tabs **318** spaced symmetrically about the periphery of the shoulder, but symmetrical placement of the tabs is not required. The tabs may be of various widths and shape and may be set at various spacing about the shoulder. The tabs provide enough contact with the bearing to hold the cap retainer in place while being insert molded and the openings separating the tabs provide more contact between the injection molded material of the pulley body and the outer race of the bearing. The contact between the pulley body and the outer race helps prevent the outer race from moving relative to the shell, i.e., prevents slipping of the bearing.

Regardless of the embodiment of the cap retainer it may be made of any suitable material or combinations of materials. Suitable materials may include metals, composites, plastics, or combinations thereof. Metal includes generally pure metals, metal alloys, and compositions containing metal or metal alloys. Plastics include injection molded plastics that are thermoset or thermoplastic.

The cap retainer may be formed by stamping, for example using progressive stamping techniques. In another embodiment, the cap retainer may be formed from powder metal by press and sintering techniques. In another embodiment, the cap retainer may be a molded piece.

When any of the various embodiments of the cap retainer are positioned on the bearing, the plate portion of the cap retainer is juxtaposed with the upper surface **181** of the outer race **109** and the flange portion is juxtaposed with the outer surface **184** of the outer race **109**. The cap retainer and bearing are placed into a mold and the pulley body is molded thereto.

Now referring to FIGS. **1** and **6-7**, bearing cap **140** generally includes a top **142** having one or more sidewalls **146** and optionally may include a shoulder **144** that transitions the top **142** into the one or more sidewalls. The bearing cap **140** may also include a rim **148** at the end of the sidewall **146** opposite where it connects to top **142** or shoulder **144**.

Bearing cap **140** includes appropriate feature(s) on the interior or exterior of the sidewall **146** or rim **148** to connect it to the neck **114** of the cap retainer **104**. In the case of spot welding or spin welding the bearing cap **140** to neck **114**, no such features may be needed. However, if the cap retainer's neck **114** includes an inside or an outside snap-fit feature, then the bearing cap **140** on the interior or exterior of the sidewall **146** or the rim **148** will have a snap-fit connector **150** configured appropriately to mate with the snap-fit feature present on the neck, such as the outside snap-fit connector shown in FIG. **7**. Likewise, if neck **114** is threaded, then the bearing cap **140** will be configured to screw onto the neck. In another embodiment, the bearing cap may include latches to connect to neck **114**, if so then the neck will include whatever hooking means is needed to secure the latch (not shown). In another embodiment, the bearing cap **140** may be configured to deform to secure the sidewall or rim of the neck **114** in response to pressing the center of its top. If such a bearing cap is utilized, the neck of the cap retainer should include a lip designed to receive and retain the end of the sidewall or the rim. One skilled in the art will appreciate that the bearing cap may include a combination of features to secure the bearing cap to the cap retainer's neck.

Bearing cap **140** may be made of any suitable material or combinations of materials, such as metals or plastics, including injection molded plastics. A molded bearing cap **140**, such that shown in FIGS. **6** and **7**, may include one or more slots **152** in rim **148**, or alternately the edge of the sidewall **146** if no rim is present. The slots **152** may be present to enable a tool to eject the molded bearing cap from a mold.

In another embodiment, bearing cap **140** may include an umbrella **154** as shown in FIGS. **9** and **10**A-**10**B. This umbrella bearing cap is generally designated **140'**. In FIG. **9**, bearing cap **140'** is shown as part of a pulley assembly general designated **100'** that contains a pulley **101** having an axis of rotation **105**, a mounting base **170** for seating the pulley thereon, a cap retainer **104"**, and a fastener **176**. Other than the alternate cap retainer **104"** and bearing cap **140'** the other components and features of pulley assembly **100'** are the same as FIG. **1** with corresponding reference numbers. Those components and features of the bearing cap **140'** that are the same as the bearing cap **140** have corresponding reference numbers.

Bearing cap **140'** generally includes a top **142** having one or more sidewalls **146** and optionally may include a shoulder **144** that transitions the top **142** into the one or more sidewalls and transitions into a cover **156** portion of umbrella **154**. The bearing cap **140** may also include a rim **148** at the end of the sidewall **146** opposite where it connects to top **142** or shoulder **144**. Umbrella **154** includes cover **156** extending outward from the top **142** and/or shoulder **144** of the bearing cap. Cover **156** may extend outward and downward at an angle sloping away from the top **142**, which will direct the umbrella **154** toward the pulley body **106**, but is not limited thereto, and may be configured to extend beyond the portion of the pulley body **106** that forms the bearing housing portion **128**. A flange **158** may be included that extends from cover **156** at an end opposite where the cover connects to the top **142** with the flange extending downward from the outer periphery of the cover **156**, which directs the flange toward the pulley body. As shown in FIG. **9**, cover **156** extends beyond the bearing housing portion **128** with flange **158** positioned past the neck **129** of the bearing housing portion **128** of the pulley body **106** to form a second line of defense against contaminants. Flange **158** may form a labyrinth seal. In one embodiment, the pulley body **106** may include a groove in the exposed side **117** of the pulley body **106** to receive the flange **158** to form the labyrinth seal or to form a contact seal.

In FIG. **9**, bearing cap **140'** is shown connected to cap retainer **104"** where the inside snap-fit recess **121'** of cap retainer **104"** (FIG. **3**B) received the outer portion of rim **148** of bearing cap **140'**. As shown in FIG. **9**, rim **148** may be configured with a hook-shaped snap-fit connector **150** for use with a cap retainer having an outside snap-fit configu-

ration. Bearing cap **140'** may also include one or more slots **152** in rim **148**, best seen in FIGS. **10**A-**10**B.

Now referring to FIGS. **1** and **9**, pulley **101** may include an arm side shield or **160'** positioned on the lower surface **112** of the bearing **102** to shield the bearing from dust and other contaminants. Arm shield **160** includes an annular plate **162** and a continuous flange **164**. While arm side shields **160**, **160'** are shown in more detail in FIGS. **8**A and **8**B, one skilled in the art will appreciate that other configurations for a shield may be used. Arm side shield **160**, shown in FIG. **8**A, comprises a generally annular plate **162** defining a generally central opening **166** and has a continuous flange **164** extending generally downward away from the outer periphery of the plate **162**. Opening **166** may receive the mounting base **170** of the tensioner arm and should be sized to provide the appropriate clearance. The arm side shield **160** may be positioned on the bearing **102** so the plate **162** lies adjacent the lower surface **112** of the bearing and the flange **164** extends over the side of the bearing to lie adjacent to the outer surface of the bearing's outer race **109**.

An alternate embodiment for the arm side shield, generally designated arm side shield **160'**, is shown in FIG. **8**B. The arm side shield **160'** includes a generally annular plate **162'** defining a generally central opening **166'** and has a discontinuous flange **165** comprising tabs **167** similar to the flange and tabs described above for cap retainer **304** in FIG. **5**. The arm side shields **160**, **160'** may be made of the same material(s) as the cap retainer.

The embodiments of this invention shown in the drawing and described above are exemplary of numerous embodiments that may be made within the scope of the appended claims. It is contemplated that numerous other configurations of the tensioner assemblies may be created taking advantage of the disclosed approach. In short, it is the applicant's intention that the scope of the patent issuing herefrom will be limited only by the scope of the appended claims.

What is claimed is:

1. A method for assembling a pulley assembly, the method comprising:

providing an injection mold configured to form a pulley body;

positioning a bearing comprising an inner race, an outer race, and a rolling element between the inner race and the outer race in the injection mold;

positioning a cap retainer on an upper surface of the bearing, the cap retainer comprising a hollow neck configured to receive a bearing cap and a plate extending outward from the neck with the neck protruding upward from the plate, wherein the neck defines an opening that allows for access to the bearing, and the neck defines at least one feature to connect the bearing cap to the neck; and

injecting a resin into the injection mold to form a pulley body integrally molded to the bearing and the cap retainer.

2. The method of claim **1** wherein the cap retainer further comprises a continuous or discontinuous flange extending downward from the outer periphery of the plate.

3. The method of claim **2** wherein the plate is adjacent to the upper surface of the bearing and the flange is adjacent to an outer surface of the outer race of the bearing.

4. The method of claim **1** further comprising positioning a shield on a lower surface of the bearing before injecting the resin, the shield comprising a plate having a generally central opening and having a continuous or discontinuous flange extending from the outer periphery of the plate, wherein the plate is adjacent the lower surface of the bearing and the flange is adjacent an outer surface of the outer race of the bearing.

* * * * *